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Effect of the heat-induced corrosion on the mechanical behavior of Eurofer97 derived by instrumented indentations

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Motivation

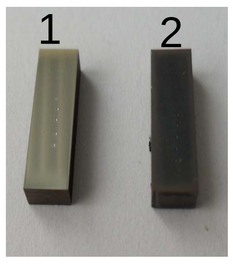
*Further characterizations of the mechanical behavior of **Eurofer97** up to **550 °C** are required. A new instrumented macroindentation device was designed [1] and is currently constructed for that purpose (see Poster Session D 15-267). It is featured by a vacuum chamber to minimize oxidation at the sample during testing at high temperature. The impact of **heat-induced corrosion effects** on the **surface** and the **mechanical properties** is examined here in advance by means of Auger electron spectroscopy-**AES**, scanning electron microscopy- **SEM,** and **instrumented indentations** at room temperature (the indentation procedure is detailed in [2]).*

Sample preparation

Materials: **Eurofer97** (9 wt.%-Cr)

Polishing: 3 µm diamond suspension

Specimens: **13×4×3 mm³**
(halves of irradiated Charpy V-notched small-sized specimens)



1: vacuum-heated sample
(High vacuum-HV: **10^{-5} mbar**)

2: air-heated sample

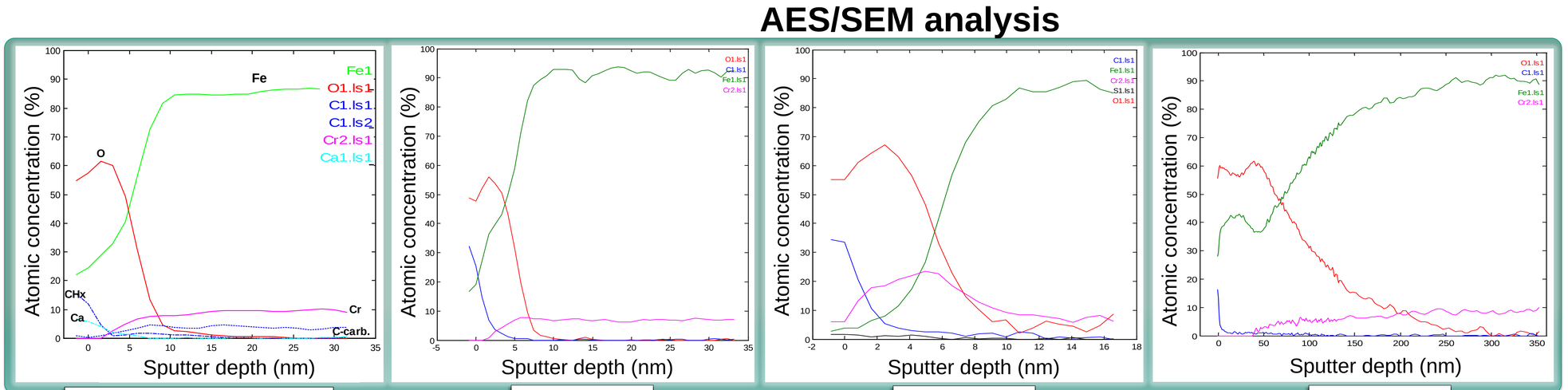
Sample appellation:
V/A-TTT-H

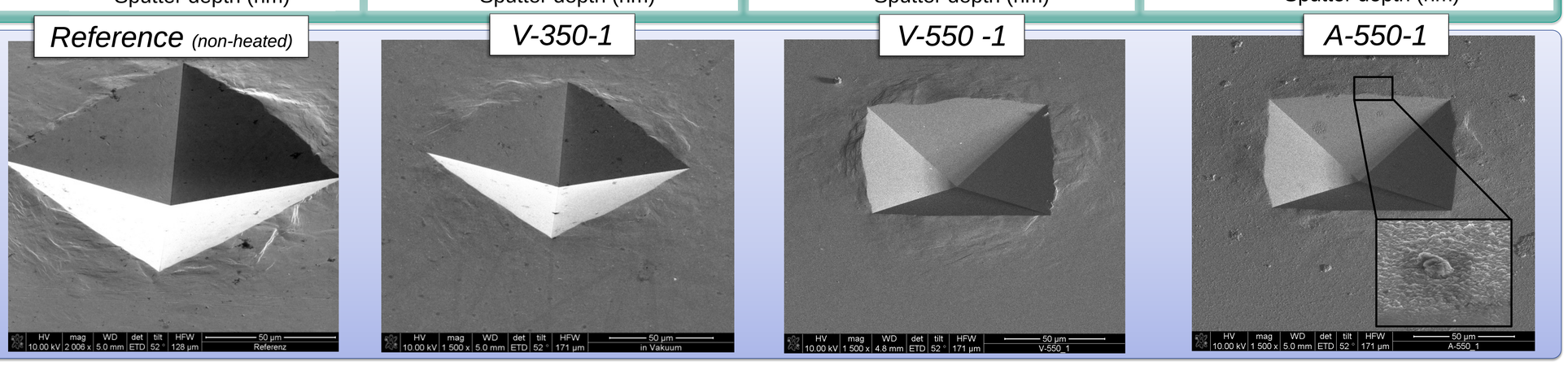
Heating conditions:

Temperature (T)	250 °C		350 °C		450 °C		550 °C	
Atmosphere: -Air (A) - High Vacuum (V)	A	V	A	V	A	V	A	V
Heating time (H)	-	1h-3h	-	1h-3h	-	1h-3h	1h-3h	1h-3h

Sample analyses

AES/SEM analysis





*-Fe_2O_3 and Cr_2O_3 layers (thinner than **8 nm**) **stable** up to 550°C in vacuum atmosphere (HV)*

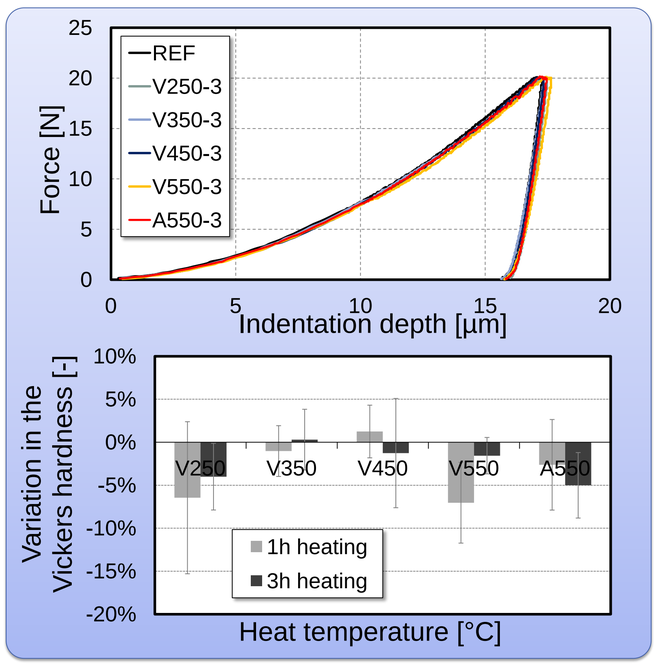
*-**Growth** of Fe_2O_3 layer (thicker than **250 nm**) for samples heated at 550°C in air-atmosphere*

*- Aspect of the polished **surface** remains **stable** for samples heated up to 550°C in **HV** atmosphere*

*- Porous and **non homogenous surface** observed,oxide particles visible for samples heated at 550°C in **air atmosphere***

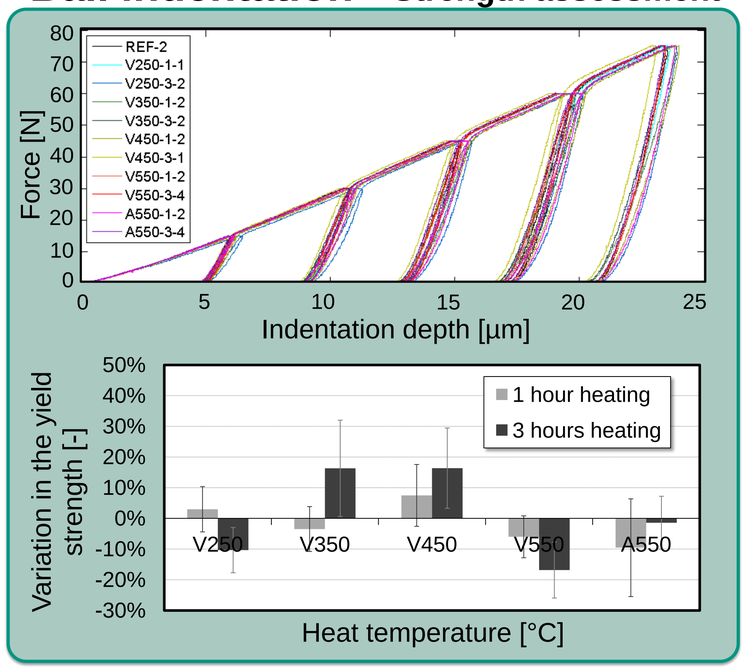
Sample testing

Vickers hardness test



*- Discrepancy up to **7%** between the average hardness of each heated samples*
- No clear dependency to the temperature

Ball indentation – Strength assessment



*- Discrepancy between all indentation curves, and assessed strengths lower than **6%** and **17 %** resp.*
- No clear dependency to the temperature

Conclusions

- *The growth of the **oxide layer** observed at high temperature (550°C/3h) remains for both tested atmospheres at the **nanometer scale***
- *The heating atmosphere plays a noticeable role in the growth of oxides, at 550°C/3h a **HV** atmosphere helps **decreasing** the formation of a superficial oxide layer by **97 %** for Eurofer97*
- ***No clear trend to hardening** was observed in the assessed mechanical properties that might result from the growth of a hard oxide layer formed by increasing the temperature*
- ***Slight** but not clearly defined **changes** in the mechanical properties are expected to occur during **indenting at high temperature** with the new instrumented indentation device*

Literature

[1] I. Sacksteder, and H.-C. Schneider, *Fus. Eng. Des.,*2010
[2] N. Huber et al*., J. Nucl. Mater*., 377, 2008, 352-358.

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